LPR 5300.1
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Langley Research Center

SPACE PRODUCT ASSURANCE

National Aeronautics and Space Administration

Responsible Office: Office of Safety and Mission Assurance

PREFACE

P.1 PURPOSE

This Langley Procedural Requirements (LPR) sets forth the implementation requirements for the National Aeronautics and Space Administration's (NASA's) Langley Research Center (LaRC) policy, procedures, and practices relative to space product assurance.

The Office of Mission Assurance (OMA), Office of Safety and Mission Assurance (OSMA) is the LaRC contact for space product assurance (PA). OMA is responsible for the issuance, distribution, and control of this LPR. Revisions will be reviewed with affected organizations and documented on a Transmittal Notice.

This LPR is one of the LaRC LPR's that comprises the LaRC Mission Assurance Manual (MAM). Compliance with the requirements of the LaRC MAM is essential to ensure the successful accomplishment of LaRC's mission in an efficient and cost effective manner. It is the responsibility of each member of the staff to work together to achieve this goal.

P.2 APPLICABILITY

The requirements of this LPR are applicable to all LaRC projects which produce, launch, and/or operate space products. This includes products developed, fabricated, or integrated at LaRC and other NASA centers, procured from contractors, or obtained from academic or other institutions.

P.3 AUTHORITY

See Appendix B

P.4 REFERENCES

See Appendix B

P.5 CANCELLATION

LAPG 5300.1, dated January 1999 should be destroyed.

Delma C. Freeman, Jr.
Deputy Director

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Chapter 1

INTRODUCTION

1.1 GENERAL

This Section identifies the Langley Research Center (LaRC) internal product assurance (PA) requirements and activities to produce, launch, and operate space products designed, fabricated, and/or managed at LaRC or to procure a contractor for providing these products and/or services. Space products include flight and qualification hardware, software, firmware, and critical ground support equipment (GSE). The requirements and activities identified herein, form the basis for the development of space project unique Product Assurance Plans (PAP's).

1.2 MISSION SUCCESS CRITERIA

The sponsoring LaRC organization and the principal investigator, if applicable, shall establish Mission Success Criteria (MSC) for each project. The MSC shall document the mission science requirements, required data products, and a numerical Reliability Goal (RG) for a specified mission duration, which if satisfied, will deem the mission to be successful.

1.3 IMPLEMENTATION

Space project PA activities will comply with the requirements of this LPR and are initiated as follows:

a. The Project Implementation Office shall initiate Office of Mission Assurance (OMA) involvement in the preparation of an internal Project Description and/or Statement of Work (SOW) for contracted activities.

b. OMA shall assign a Product Assurance Manager (PAM) to assist the project in establishing the MSC.

c. Project personnel shall meet with the PAM to scope the PA activities required to achieve the specified MSC.

d. The PAM, in conjunction with project personnel, shall develop a PAP for PA activities performed internal to LaRC in accordance with the applicable requirements of this document.

e. For contracted PA activities, the PAM, in conjunction with project personnel, via the Office of Procurement (OP) coordination, shall establish PA requirements for inclusion in the project SOW and Request For Proposal (RFP). The RFP may require the submittal of PAP elements with the contractor proposal that satisfies the PA

requirements outlined by this document. A contractor developed PAP shall be required as a government approved deliverable following contract award.

f. The Head of OMA and the Project Manager (PM) will review and approve the PAP or RFP PA requirements.

Chapter 2

PRODUCT ASSURANCE PLAN

2.1 GENERAL

All LaRC space projects, regardless of cost or where managed, must have a PAP developed in accordance LMS-CP-4750 “Develop Product Assurance Plans.” Project offices shall ensure that sufficient funding is available for PAP development and implementation.

2.2 CONTENT

The PAP shall identify the applicable requirements of this document necessary to achieve the specified MSC. An organizational chart shall be included which identifies individuals responsible for the specified product assurance deliverables and support activities. A sample PAP outline is provided in Appendix C.

2.3 APPROVAL

All space related PAP’s shall be approved by the Head, OMA, and the LaRC Project Manager. In addition, the following steps are applicable to PAP’s developed by contractors in response to a LaRC RFP, whether competed or sole sourced:

a. OMA evaluates the proposed PAP as to its adequacy for assuring the desired MSC is achievable.

b. The selected contractor’s proposed PAP, with negotiated additions, modifications, and subsequent revisions is approved by OMA.

c. The contractor shall submit an approved PAP at the Preliminary Design Review (PDR) and an updated, if required, PAP 30 days prior to the Critical Design Review (CDR) for OMA approval.

d. Upon OMA approval, the contractor PAP is baselined and placed under the project configuration control system (see Chapter 4).

2.4 CHANGES

All changes to an approved PAP shall be subject to the configuration management process. PAP’s shall be promptly updated to include all approved changes.

2.5 ASSESSMENT

All PA activities identified in an approved PAP shall be subject to audits or reviews by OMA, or its designee. These audits or reviews will insure compliance with identified PA requirements and ascertain that personnel performing PA activities have the required training and skills for the successful completion of their tasks. All identified deficiencies shall be promptly corrected by the responsible organization.

OMA, or its designee, shall have the authority to stop ongoing work or prevent work from commencing on any LaRC activity, or to request the Contracting Officer Technical Representative (COTR) to stop work on any contractor activity assessed to be noncompliant with an approved PAP.

2.6 RESPONSIBILITIES

The Office of Mission Assurance (OMA) is responsible for:

a. Preparation and maintenance of the PAP for in-house projects.

b. Submitting in-house PAP's for project approval.

c. Establishing PA requirements for the statement of work on space-flight projects performed by contractors.

d. Reviewing contractors' PAP's.

e. Head, OMA, approves in-house PAP's.

f. Conduct audits or reviews to assure implementation of PAP's for in-house and contracted projects.

The Project Manager (PM) is responsible for:

a. Approving PAP's.

b. Managing implementation of the PAP.

Chapter 3

ACQUISITION QUALITY ASSURANCE

3.1 GENERAL

This chapter identifies requirements and procedures to ensure that suppliers, contractors, and subcontractors deliver products and services which comply with LaRC PA requirements. Purchases of hazardous materials shall be in accordance with LMS-CP-4759, “Receipt, Handling, Storage, Marking, Preservation and Delivery of Hazardous Materials.”

3.2 ACQUISITIONS

Space products and services are acquired by purchase orders, credit cards, and contracts. Purchase requests are necessary to initiate procurement actions.

3.2.1 Purchase Requests

Using the Electronic Purchase Request System (EPRS), originators of a purchase request (PR) for the acquisition of space-flight hardware or for the development of space-flight software are to comply with the requirements of LMS-CP-4703 “Review of Purchase Requests by the Office of Safety and Mission Assurance (OSMA).”

The Product Assurance Manager (PAM) will review the submitted PR to determine if adequate PA provisions are included (per the requirements of this document), if PA evaluation of proposed subcontractors is required, and if Government source inspection is required.

As a minimum, the PAM will assure that the following have been considered for inclusion:

a. PA Requirements.

b. Delegation of quality assurance (QA) provisions to other Government agencies.

c. Department of Defense (DD) Form-250, “Material Inspection and Receiving Report.”

d. Information to supplier for special shipping instructions.

e. Pre-award survey.

f. Inspection/acceptance testing requirements (including acceptance/rejection criteria).

g. Safety and environmental considerations.

The PAM will prepare any additional required PA and delegation documentation and attach appropriate receiving and inspection instructions. All space products PR's shall be approved by OMA.

3.2.2 Credit Cards

The use of Government credit cards does not relieve an individual from the responsibility of complying with the PA requirements of this document. Space products purchased using credit cards must adhere to the receiving and inspection requirements in Chapter 7.5.

3.2.3 Contracts

The Office of Procurement (OP) shall ensure that a copy of the proposed SOW for development of space-flight hardware and software is forwarded to OMA as per LMS–CP-4751, “Response to Requests for Mission Assurance Support in Proposal or Contract Development.” The PAM, in conjunction with project personnel, will prepare the Product Assurance Requirements (PAR) Appendix for inclusion in the proposed SOW. The PAR is to be based upon the requirements of this document. The PAR shall become part of the contract negotiated between the contractor and LaRC.

In addition, the PAM will develop a “Documents Requirements List (DRL),” NASA Langley Form 47, which identifies required PA documentation to be submitted to LaRC during the contract period. The DRL is to identify the following:

a. Name of required document.

b. Reference paragraph of PAR’s Appendix.

c. Submittal frequency.

d. Updating frequency.

e. Distribution.

f. LaRC action required.

A “Data Requirements Description (DRD),” NASA Langley Form 45, will be prepared which identifies the content and format requirements for each document identified in the DRL.

The OP shall ensure that all RFP’s and resultant contracts require the contractor to comply with the OMA approved PAR when developing the PAP.

The procurement package development process is to include reviews at various milestones as defined by OP and PM. During these reviews, the PAM is to ensure that appropriate language is included in the RFP for the following:

a. Compliance to PA requirements.

b. Reference to mandatory QA elements of the Federal Acquisition Regulations (FAR's).

c. Surveillance plans to assure compliance.

3.2.4 Responsibilities

The Office of Mission Assurance (OMA) is responsible for:

a. Reviewing all PR's and RFP's to determine if adequate PA provisions have been included, if PA evaluation of proposed suppliers might be required, and if Government Source Inspection may be required.

b. Coordinating with the originator of the PR action recommended from the PA review.

c. Signing and dating the PR in the PA approval block and forwarding, with associated documents, to the next functional office in the approval process.

d. Preparing all PA related NASA Langley Forms 45 and 45A.

Office of Procurement (OP) is responsible for:

a. Assuring that PR (RFP if applicable) has been reviewed by the OMA.

b. Adding PA provisions to appropriate procurement documents.

c. Inviting the designated PA representative to proposal/source evaluations and contract technical negotiations.

d. Sending the assigned PA representative a copy of Purchase Request/Contract, contract modifications, and other documents, which may affect the PA program or product.

e. Delegating PA functions to other Government agencies as specified by OMA.

The originator of the PR is responsible for:

Contacting the OMA early in the procurement definition phase, forwarding PR and all associated documents to the OMA when review is required.

3.3 DELEGATION OF QUALITY FUNCTIONS

Delegation of quality functions to another agency will be done on selected procurements. OMA will provide the OP with a description of the delegated functions. The basic elements to be evaluated by the Delegated Agency (DA) in the Letter of Delegation (LoD), includes, but is not limited to procedure approvals, bonded stores, configuration management, contamination control, engineering model, fabrication control, failure reporting and corrective action, metrology, parts and materials, processes, receiving inspection, software quality assurance, software testing, supplier audits, hardware testing, inspection, training and certification. The DA may be required to submit a Quality Assurance (QA) Plan.

The OP will prepare a LoD, NASA Form 1430, “Letter of Contract Administration Delegation, General,” which includes clear intent and definitive authorities. The LoD does not revoke LaRC’s ultimate responsibility, but provides for LaRC’s right to intercede.

3.3.1 Criteria

The need for delegation to another agency at or near LaRC contractor facilities will be established by consideration of the following criteria:

a. Inspection at any point other than the source would require uneconomical disassembly or destructive testing of the deliverables to ensure compliance.

b. Considerable loss of time or funds would result from the manufacture and shipment of unacceptable hardware or from the delay in making necessary corrections.

c. Special instruments, gages, or facilities required for inspection or test are available at source and are not readily available to the LaRC organization responsible for acceptance.

d. Government inspection at any other point would destroy or require the replacement of costly special packing or packaging.

e. Quality control and inspection requires verification of process controls that are critical to the product, and can be accomplished only at the contractor’s facility. Deliverables requiring technical inspection are to be shipped to locations other than LaRC.

f. Inspection and testing will be done at the contractor’s facility to determine product compliance and acceptance, and will not be repeated after delivery and installation.

g. OMA workload and available OMA personnel.

3.3.2 Implementation

Once the need for delegation has been established, the PAM will implement the following actions based upon the preceding criteria:

a. Prepare and deliver delegation requirements, including the names, mail codes, and telephone numbers of the QA representatives, to the Contracting Officer (CO) for inclusion in the overall delegation.

b. Contact the DA to make initial arrangements and generally discuss the contract and delegation assignments.

c. Participate with the DA to finalize delegated supplemental QA instructions, discuss manpower, the DA QA plan, and identify reports and submittal frequency to OMA.

d. Review and approve the DA QA Plan.

e. Monitor the implementation of the LoD during the contract duration to assure the QA delegation is being accomplished; adequate, capable manpower is being provided; required reports are being submitted; and proper records are maintained.

If a Materials Review Board (MRB) is authorized in the contract, the DA will provide a representative, authorized by LaRC, to serve on the MRB (see Chapter 7.8).

3.3.3 Delegation to Other NASA Field Installations

Under certain conditions it may be advantageous or necessary to delegate directly to another NASA field installation. These conditions are as follows:

a. To support tests or launches being performed at another NASA facility.

b. Technical expertise to perform delegated functions is not readily available from the agency that would normally perform these functions.

c. It is in the best interest of the Government.

Delegation is to be administered in a manner that does not affect the contractual relationship between the contractor and LaRC, or between the contractor and subcontractor. Delegation to other NASA field installations will be managed the same as a delegation to another agency but may not require a QA plan or other elements specified above depending on the extent of the inspection required.

3.3.4 Responsibilities

Office of Procurement (OP) will:

a. Provide a copy of NASA Form 1430, “Letter of Contract Administration Delegation, General,” and NASA Form 1430A, “Letter of Contract Administration, Special Instructions,” including the QA delegation requirements to the Head, OMA, for review prior to submittal to the agency.

b. Provide a copy of the final letter of delegation issued to the agency to Head, OMA.

Office of Mission Assurance (OMA) will:

a. Determine, upon receipt of a PR, if a letter of delegation is necessary.

b. Prepare and deliver the QA delegation requirements to the Contracting Officer for inclusion in the overall delegation. Include with these requirements the names of the QA representatives, mail codes, and telephone numbers.

c. Contact the DA to make initial arrangements and generally discuss the contract and the delegation assignments.

d. Arrange and participate in a planning conference with the DA to:
(1) Finalize the delegated supplemental QA instructions,
(2) Discuss manpower,
(3) Review the DA QA plan, and
(4) Identify reports to be submitted to NASA.

e. Arrange and participate in a post-award conference with the DA, if necessary, to review and discuss the applicable items stated in Paragraph. 4, above, the contractor’s PA program and PAP, and delegations for major subcontracts.

f. Monitor the DA during the contract duration to assure that the QA delegation is being accomplished; that adequate, capable manpower is being provided; and required reports are being submitted and records maintained.

3.4 CONTRACT DEVIATIONS AND WAIVERS

3.4.1 General

LaRC contracts for space products and services will provide for Deviation and Waiver Requests (DWR’s). DWR’s are to be prepared using NASA Langley Form 147,

"Contractor Deviation/Waiver Request," and submitted to the CO and/or the Contracting Officer's Technical Representative (COTR).

3.4.2 Responsibilities

The Project Manager (PM) will:

a. Assure provisions for Deviation/Waiver Requests (DWR's) are incorporated into statements of work.

b. Obtain comments and recommendations from the appropriate project support personnel on matters relating to the DWR.

The Contracting Officer (CO) will:

a. Receive, distribute to project managers, and contractually approve all DWR's received from the contractor. Provide notification of approval/disapproval to the contractor on all DWR's.

b. Prepare and implement contract modifications for DWR's approved as necessary.

c. Assure delegated Government agencies at the contractor's plants are notified of the disposition of the DWR's.

The Product Assurance Manager (PAM) will:

a. Provide comments and recommendations on DWR's where the DWR is related to program assurance.

b. Obtain comments and recommendations from the cognizant delegated Government Quality Assurance representative on DWR's.

c. Provide recommendation for DWR approval/disapproval to the Project Manager.

The Contracting Officer's Technical Representative (COTR) will:

a. Provide comments and recommendations on DWR's when it affects safety, durability, performance, design, or interchangeability of parts or assemblies.

b. Provide recommendation for DWR approval/disapproval to the PM.

Chapter 4

CONFIGURATION MANAGEMENT

4.1 GENERAL

This chapter identifies the CM requirements and procedures to accurately define and control the "as-is" configuration of space products. The PAP will detail the Project CM Plan or shall require the submittal of a CM Plan developed from the requirements of this chapter. Size and complexity of the project dictates the submittal of a separate CM Plan. All LaRC and contractor CM plans shall be approved by OMA. Contractor CM plans will be reviewed against the requirements of this chapter.

Use of the LaRC Configuration Management on-line (CMOL) system is the preferred method of conducting LaRC CM activities. CMOL is a software system, which allows electronic storage, retrieval, viewing, printing, indexing, and editing of documents from the desktop computer. The CMOL system does not permit on-line changes without secured access approval.

Existing contractor electronic or commercial off-the-shelf CM systems may be utilized and will be detailed as part of the CM Plan. In such instances, LaRC shall be provided the necessary hardware, software, instructions, and training to gain access to and print all safety and mission assurance critical documentation.

4.2 IMPLEMENTATION

Based upon project complexity and cost, the Space Projects Office (SPO) will make the determination if CM is to be out-sourced. If CM is to be performed in-house, the following process applies:

a. The Project Manager will appoint a CM manager.

b. The appointed CM manager will meet with the PAM to scope the required CM activities. The CM Manager will provide an estimate of resources required for implementation if CMOL is to be used.

c. The appointed CM manager will then develop the CM plan and submit to OMA for approval.

4.3 CONFIGURATION ITEMS

The CM plan will identify the applicable Configuration Items (CI's) and Computer Software Configuration Items (CSCI's) of subsystems, components, assemblies, subassemblies, parts and devices, GSE, and system calibration equipment during design, development, fabrication, and test that will be placed under CM control.

4.4 CONFIGURATION IDENTIFICATION

Documents (plans, specifications, procedures, processes, and other technical documentation) and drawings that identify and describe CI's and CSCI's are to be assigned numbers at the time of completion.

4.4.1 Documents

All documents will have a cover page, which identifies the common, frequently used attributes to facilitate tracking: Project Name, Document Title, Issue Date, Originating Organization/Person, Status, and Document Number. A project may want to add to or tailor the cover page to more adequately configure the particular document.

Revisions to documents are to be noted on a revision page index, which includes reference to the appropriate section, paragraph, and page; purpose; signature approval; and revision date. The actual marking of changes is at the discretion of the individual project, but vertical bars are to be placed adjacent to the line(s) being revised on the left-hand margin. All previous revisions are to be accessible.

4.4.2 Drawings

All parts, assemblies, and installations required to make up a CI are to be completely defined by engineering drawings. A NASA Langley Form 33, "Drawing Record Card," is to be prepared for each LaRC engineering drawing and schematic. The preprinted number on the form is to be affixed to the corresponding drawing.

Approval procedures for drawings are to be identified in the CM Plan. All completed approved drawings, including a hard copy of electronically generated drawings, are to be submitted to and maintained by the LaRC Engineering Drawing Files.

Commercial off-the-shelf items are exempt from this requirement.

4.4.3 Hardware

All parts and assemblies are to be identified by an identification number as per section 7.7 of this document.

4.4.4 Software

CSCI's requiring identification are computer programs and files which include, but are not limited to, diagnostics and actual programs, support, data, control files, etc. All CSCI's will have a version number, file number, description, etc.

4.4.5 Firmware

Firmware items requiring identification include Read Only Memory (ROM), Programmable (P) ROM, Erasable (E) PROM and Electrically (E) EPROM.

4.5 BASELINE MANAGEMENT

Baselines will be identified and established at key control points in the life cycle of the project and will serve as reference points from which change control is initiated. Configuration control does not start until a CI or CSCI is baselined.

4.6 CONFIGURATION CONTROL

Systematic procedures by which changes to a CI or CSCI are proposed, evaluated, implemented, and made are to be established and documented. Contract deviations and waivers are formal changes and are to be included in the configuration control process.

4.6.1 Configuration Control Board

A Configuration Control Board (CCB) is to be appointed and chaired by the Project Manager. The CCB's primary responsibility is to act on proposed changes and to ensure complete impact assessment and analysis. The evaluation and disposition of all change requests are to be documented on NASA Langley Form 182, "Configuration Control Board Report." Additionally, the CCB will ensure that any change made subsequent to an established baseline is traceable back to that baseline. The membership of the CCB is to be identified in the CM plan.

4.6.2 Change Control

The purpose of change control is to ensure that "in-use" documentation is current and that changes are permitted to occur only through the CCB approval process. Details of the change control process are to be provided in the CM plan. NASA Langley Form 181, "Configuration Change Request (CCR)," is to be prepared for proposed changes to approved baselined documents. All changes are to be classified as follows:

a. Class I - Changes which impact cost, schedule, performance, interface, or other project defined criteria.

b. Class II - Changes which correct documentation errors, add clarifying notes, etc.

A unanimous CCB decision is required for approval or disapproval of a CCR; however, the Project Manager retains final approval or disapproval authority.

4.7 CONFIGURATION ACCOUNTING

A records system is to be maintained which assures the systematic recording and reporting of information required for the complete identification of the configuration. The system will be maintained to provide the following:

a. Tractability control down to the purchase order and lot level.

b. Lists which identify all drawings, specifications, procedures, plans, and other documents under configuration control.

c. A separate indentured drawing list showing all assembly numbers and the part numbers within the assemblies.

d. A list defining the quantity of parts, the next assembly, and the subsystem in which the part is installed with the current physical location of each.

e. A list of all Class I and Class ll changes.

f. A list of Deviations/Waivers.

4.8 CONFIGURATION VERIFICATION

OMA, or its designee, will perform periodic reviews of design, fabrication, assembly, integration, and testing phases with emphasis on verifying that the configuration is identifiable and that changes are traceable to an established baseline and the design drawings and hardware are in conformance.

4.9 RESPONSIBILITIES

The Project Manager (PM) is responsible for:

a. Appointing a CM Manager.

b. Determining the degree of control from one baseline to the next.

c. Appointing members to the CCB.

d. Serving as the Chairperson of the CCB.

e. Establish key baseline control points.

The Configuration Management (CM) Manager is responsible for:

a. Developing the CM Plan.

b. Implementing the CM Plan.

The Office of Mission Assurance (OMA) is responsible for:

a. Approval of the CM Plan.

b. Performing periodic audits or reviews of the CM Plan implementation.

c. Serving on CCB's as assigned.

Chapter 5

DESIGN ASSURANCE

5.1 GENERAL

This chapter identifies the design assurance review requirements and reliability tools necessary to evaluate the product design. Design Reliability (DR) computations, utilizing accepted failure rate and design configuration data, are to be performed and coordinated with design personnel during the early phases of design. As more definitive information becomes available, computations shall be performed iteratively to ensure that the DR is equal to or exceeds the Reliability Goal (RG). As this process develops, design changes may be required.

5.2 DESIGN REVIEWS

5.2.1 General

OMA will work in conjunction with LaRC design personnel to implement a design assurance program which interacts with all product assurance elements to assure the design meets established requirements. This activity will be initiated during the conceptual design phase and may include the review of and concurrence with design specifications, drawings, and procedures prior to release. The design review schedule will be specified in the PAP.

The following sequential set of design reviews is typical for LaRC space projects:

a. Systems Requirements Review (SRR).

b. Conceptual Design Review (CoDR).

c. Project Requirements Review (PRR).

d. Preliminary Design Review (PDR).

e. Critical Design Review (CDR).

f. Other formal reviews as established by the Program Manager.

The PAM will support the project in preparation for and present the status of all product assurance activities at all design reviews.

5.2.2 Responsibilities

The Project Manager (PM) is responsible for:

a. Determining the design reviews to be conducted for the project.

b. Conducting each design review.

The Product Assurance Manager (PAM) is responsible for:

a. Ensuring design reviews are conducted.

b. Presenting the status of the Product Assurance activities at each design review.

5.3 Design Reliability

5.3.1 Fault Tree Analysis

A Fault Tree Analysis (FTA) will be performed on systems, subsystems, and equipment. The FTA is a quantitative tool used to predict DR. The FTA will provide a systematic and deductive methodology for defining a single specific undesirable event and determining all possible failures that could cause that event to occur. The FTA will be utilized during the initial design phase as an evaluation tool for driving the preliminary design. Upon completion of fabrication, the results of the FTA may be utilized as a troubleshooting tool. The Dynamic Innovative Fault Tree (DIFtree) Analysis Program, or its equivalent, is the preferred method of performing the FTA.

5.3.2 Failure Modes and Effects Analysis

A Failure Modes and Effects Analysis (FMEA) will be performed which documents the systematic consideration of all likely ways equipment or components can fail, the causes for each failure mode, and the effects of the failure. This analysis is to be scheduled and completed concurrently with the design effort such that the design will reflect analysis conclusions and recommendations.

The FMEA will be used for the following:

a. Identify single failure points.

b. Determine redundancy, fail-safe design features, and/or derating.

c. Identify system interface problems.

d. Safety and hazard analyses.

e. Identify quality inspection points.

f. Determine allowable use time or cycles.

g. Determine assembly, inspection, and test procedures.

5.3.2.1 Approach

The FMEA is initiated during the conceptual or preliminary design phase and updated as design changes are incorporated. The system or subsystem to be analyzed is to be defined from system specifications, drawings, and operational and environmental profiles. The FMEA is based upon single component failures and provides concise statements of the failure mode and its effects. The following basic failure modes are to be imposed at the lowest level of definition:

a. Premature operation.

b. Failure to operate at prescribed time.

c. Failure to cease operation at prescribed time.

d. Failure during operation.

e. Degraded operation.

The effects of a single point of failure are to be determined at the next level of definition. Although a redundant element is considered to terminate the failure effect on the system, the failure mode and effect on the subsystem is to be identified. Analysis results and pending actions is presented during the PDR and updated for the CDR and Flight Readiness Review (FRR).

5.3.2.2 Criticality Category

Criticality numbers based upon “Failure effect on” entries are as follows:

1 Single failure which could result in loss of life or vehicle.
2 Single failure which could result in loss of mission.
3 All others.

1R redundant hardware item(s), all of which if failed, could cause loss of life or vehicle.
2R Redundant hardware item(s), all of which if failed, could cause loss of mission.

5.3.2.3 Disposition and Justification

Single failure points are to be eliminated by the removal or redesign of the component or by providing redundancy. The determination and acceptance of a probability of failure will be accomplished by examining the history of the component when used previously in a similar application and/or sufficiently testing the component during the development phase of the effort.

5.3.3 Critical Items List

A Critical Items List (CIL) will be derived from the FMEA process and will identify the rationale or justification for retaining critical items. The CIL will be maintained current and presented at each design and readiness review.

Utilizing the FMEA, the following classification of failure modes, as a minimum, will be entered in the CIL:

a. All functional criticality category 1 and 2 items.

b. All functional criticality 1R items where the first failure could result in loss of mission or the next failure of any redundant item could cause loss of crew/vehicle.

c. All functional criticality category 1R and 2R items that fail one or more redundancy screens.

The CIL is to contain the following information, sequenced as indicated:

a. A concise statement of the purpose of the report.

b. A description of the major systems contained in the CIL with general information as to what type of data is contained in the CIL.

c. The rationale or justification for retaining critical items.

d. A critical hardware list which provides a listing of line replaceable unit (LRU) part numbers, reference designators, LRU nomenclature, LRU highest level criticality, lower indenture level part numbers identified by the FMEA, failure mode number, quantity of items in the subsystem, and the criticality for each FMEA number.

e. Individual pages describing the actual analysis results.

5.3.4 Responsibilities

The Project Personnel will:

a. Perform FMEA/CIL.

b. Report results at appropriate design reviews.

The Office of Mission Assurance (OMA) personnel will:

a. Provide guidance on performing FMEA/CIL.

b. Review FMEA/CILs for completion.

c. Perform independent FMEA/CILs upon request.

The Project Manager (PM) will:

a. Implement the reliability assurance requirements.

b. Approve FMEA/CILs.

5.4 PARTS AND MATERIAL ALERTS

5.4.1 General

The Government-Industry Data Exchange Program (GIDEP), the NASA Alert Reporting System (NARS), and the NASA Lessons Learned Information System (LLIS) databases are to be reviewed for quality, application, and safety problems associated with parts and materials used by the project. Any problems encountered by the project are to be documented and reported in accordance with the GIDEP, NARS, and LLIS.

5.4.2 Responsibilities

The Product Assurance Manager (PAM) will:

a. Review and coordinate applicable alerts with designers to identify and assess the use of suspect parts and materials.

b. Document problems found and forward to the LaRC GIDEP representative.

The Organizational Heads will:

a. Ensure that personnel prepare reports when appropriate for GIDEP.

b. Ensure that reports for submittal to GIDEP are accurate and complete.

The LaRC GIDEP representative will:

a. Submit reports to GIDEP

b. Ensure that reports for submittal to GIDEP are accurate and complete.

5.5 ORBITAL DEBRIS ASSESSMENT

Each mission shall conduct a formal assessment of the potential to generate orbital debris in accordance with NPD 8710.3, “NASA Policy For Limiting Debris Generation” and NSS 1740.14, “Guidelines and Assessment Procedure for Limiting Orbital Debris.”

These guidelines are applicable to all payloads, upper stages, and released objects.

The Orbital Debris Assessment (ODA) is to cover the potential for generating debris during normal operations or malfunction conditions and the potential for generating debris by collision with space debris (natural or human-generated) or orbiting space systems. The following issues are to be addressed:

a. Debris released during normal operations.

b. Debris generated by explosions and intentional breakups.

c. Debris generated by on-orbit collisions during mission operations and orbital lifetime.

d. Safe disposal of upper stages and spacecraft after mission completion.

e. Structural components impacting the Earth following postmission disposal by atmospheric reentry.

Chapter 6

PARTS AND MATERIALS

6.1 GENERAL

This chapter identifies requirements for the selection and qualification of mechanical parts and components; electrical, electronic, electromechanical (EEE) parts and components; and materials used in space products. The parts and materials (P&M) section of the PAP is to be developed from the requirements of this chapter.

All mechanical and EEE parts and components are to be identified on a Parts Inventory Report (PIR). Sufficient spares are to be procured to ensure the replacement of defective parts and parts required for destructive testing.

6.2 MECHANICAL PARTS

Mechanical parts and components include structural and mechanical piece parts, fasteners (all types), mechanical devices, and springs. All space related fasteners received at LaRC shall be verified by the Receiving Inspection and Quality Assurance Laboratory (RIQAL) or the Quality Applications Technology Branch (QATB), as specified on the PR. Upon acceptance, fasteners and their associated certification documentation will be maintained in the appropriate bonded stores area (see Chapter 7.10).

6.3 ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL PARTS

EEE parts and components include off-the-shelf components, motors, pyrotechnic devices, sensors, transducers, and detectors (i.e., all items with an electrical interface). The PAP shall require the submittal of an EEE Parts Plan to Office of Mission Assurance (OMA) for approval.

6.3.1 Implementation

The LaRC EEE Parts Manager (EPM) will coordinate the NASA Electronic Parts and Packaging Program (NEPP) with the NASA Parts Project Office of NASA Headquarters and OMA. The EPM will develop and implement the EEE Parts Plan in accordance with LMS-OP-5515, “Electric, Electronic, Electromechanical (EEE) Parts Assurance” for LaRC internal projects. The EEE Parts Plan shall be submitted to and approved by OMA prior to the PDR.

6.3.2 Standard Parts

Parts selected and procured from the NASA Parts Selection List (NSPL) or Goddard Space Flight Center (GSFC) Preferred Parts List are identified as “standard parts” and

are to be used as a first order of preference. The use of Grade 1 or Grade 2 standard parts (or their equivalents) will be determined by the ability of the product design to achieve the desired MSC. The EPM will ultimately approve all EEE parts.

6.3.3 Nonstandard Parts

Parts, which do not meet the criteria of "standard parts," are identified as "nonstandard parts." The EEE Parts Plan shall identify qualification-testing requirements for all "nonstandard parts." The Electronic Systems Branch will perform qualification testing of EEE parts. Any nonstandard parts require the submittal of NASA Langley Form 170, "Nonstandard Part Approval Request (NSPAR)," with supporting data package for LaRC consideration and approval.

6.4 MATERIALS

6.4.1 Selection

Flammability, stress corrosion, outgassing, and offgassing requirements for materials, including mechanical parts and components, shall be based upon payload cleanliness goals and spacecraft and launch vehicle requirements.

In the absence of requirements from the spacecraft/vehicle integrator, Johnson Space Center (JSC) 09604/Marshall Space Flight Center (MSFC) HDBK-527, "Materials Selection List for Space Handbook Systems," may be used for guidance in determination of material requirements.

The National Space Transportation System (NSTS), International Space Station (ISS), and some other spacecraft integrators require the submittal of a Material Usage Agreement (MUA) for materials which do not meet their flammability, stress corrosion, outgassing, and offgassing requirements. The MUA is to be routed through OMA to the spacecraft integrator's approving organization.

6.4.2 Composites

Composite materials selected for use in structural applications is to be evaluated on a case by case basis. A Composite Material Qualification Plan (CMQP) shall be submitted to OMA for approval.

6.4.3 Limited Life Items

Limited shelf life polymeric materials are to be identified and expiration dates observed. Use of materials with expired date-codes requires the submittal of test results, demonstrating that material properties have not been compromised for their intended use. Use of expired materials requires submission of the test results and justification to OMA for approval

6.4.4 Materials List

A listing of selected materials is to be developed and maintained current. The Materials List shall contain a reference to the document from which acceptability was ascertained.

6.5 Responsibilities

The Project Manager (PM) is responsible for:

a. Material selection and procurement.

b. Preparation of the Parts Inventory Report (PIR) and Materials List (ML).

c. Initiating the Material Usage Agreements (MUA) process.

The Product Assurance Manager (PAM) is responsible for:

a. Verifying material compliance through review and approval of ML's and MUA's.

b. Verifying parts compliance through review and approval of PIRs, EEE Parts Plans, CMQPs, and limited life items.

The EEE Parts Manager (EPM) is responsible for:

a. Coordinating the NASA Standard Parts Program with the NASA Parts Project Office of NASA Headquarters and OMA.

b. Developing and implementing the EEE Parts Plan for LaRC internal projects.

The Electronic Systems Branch is responsible for:

a. Qualification testing of nonstandard EEE parts.

The Receiving Inspection and Quality Assurance Lab (RIQAL) is responsible for:

a. Verifying space related fasteners received at LaRC, as specified on the PR.

The Quality Applications Technology Branch (QATB) is responsible for:

a. Verifying space related fasteners received at LaRC, as specified on the PR.

Chapter 7

QUALITY ASSURANCE

7.1 GENERAL

This chapter identifies the quality assurance (QA) requirements for the fabrication, assembly, disassembly, integration, testing, handling, preservation, and shipping of space products. The QA section of the PAP is to be developed in accordance with the requirements of this chapter.

Quality Applications Technology Branch (QATB) maintains quality assurance cognizance of space flight hardware during fabrication. The Office of Mission Assurance (OMA) will initiate and maintain quality assurance cognizance of space flight hardware and GSE upon delivery to the project.

7.2 INSTITUTIONAL SAFETY INTERFACE

7.2.1 General

All space product and associated Ground Support Equipment (GSE) fabrication, assembly, disassembly, and test operations are to comply with established LaRC safety policies and the following:

a. Work shall be terminated when any unsafe condition exists that could cause injury to personnel or damage to hardware, software, and associated GSE.

b. All assembly, disassembly, and test operations are to be conducted in accordance with written procedures approved by personnel designated in the PAP.

c. Any operations designated as hazardous (i.e., risks personnel injury and/or illness and/or property damage/destruction) are to be conducted in accordance with written procedures approved by personnel designated in the PAP and the LaRC Safety Manager.

d. Changes to hazardous operations procedures are to be approved prior to implementation.

All personnel are responsible for reporting unsafe conditions or situations to the Designated Project Engineer (DPE), Facility Coordinator, or PAM. Anyone observing an action which creates an imminent danger or hazard to personnel or equipment has the authority to have such action terminated. In such instances, the LaRC Safety Manager must be immediately notified.

7.2.2 Responsibilities

The Project Manager (PM) is responsible for:

a. Implementation of the LaRC Safety Program for the project.

The assigned QATB Quality Assurance Specialist (QATB QAS) or the OMA Quality Assurance Specialist (OMA QAS) is responsible for:

a. Assuring that neither the flight hardware nor operational personnel associated with its fabrication, assembly, testing, or handling are exposed to hazards which could cause damage to the hardware or injury to personnel.

b. Coordinating resolution of safety concerns with both institutional safety and project management.

The LaRC Safety Manager is responsible for:

a. Approving al hazardous procedures and subsequent changes for hazardous operations.

All LaRC personnel are responsible for:

a. Reporting unsafe conditions or situations to the DPE. Further, if any employee observes an action, which creates an imminent danger or hazard to personnel or equipment, that employee has the authority to have such action terminated. In such instances, the Safety Manager at LaRC, extension 4-7233, must be immediately notified.

7.3 SOFTWARE

The PAP shall require compliance with LMS-CP-5528, “Software Planning, Development, Acquisition, Maintenance, and Operation.”

7.4 METROLOGY

Procedures for the calibration and control of laboratory standards, precision measurement instruments, and test equipment used to support fabrication, assembly, and test activities are to be in accordance with LMS-CP-0506, “Selection, Use and Control of Inspection, Measuring and Test Equipment,” and LMS-CP-0510 “Procurement of Inspection, Measuring and Test Equipment (IM&TE).”

7.5 RECEIVING AND INSPECTION

Shipping and receiving personnel are to inspect space product packages for external damage only. Packages are not to be opened. Undamaged packages are to be delivered to the RIQAL or QATB, as specified on the PR. The RIQAL or QATB will assure that the acceptance criteria stated on the procurement specifications are satisfied in accordance with LMS-CP-4758, "Receipt Inspection for Safety-Critical Products."

7.5.1 Certification

Certification requirements for all metallic and nonmetallic materials, including fasteners and weld filler material, are to be specified in the PR. Documentation received with products is to be retained for traceability to the manufacturer. As a minimum, this documentation shall include the following:

a. LaRC PR number.

b. Date shipped by supplier.

c. Supplier's name and address.

d. Part number.

e. Raw material identification information.

f. Quantity accepted.

g. Contractor's inspector acceptance stamp.

A sample of the product's "parent" material (verification coupon) may be requested as part of the certification requirements.

7.5.2 Verification

The physical properties and chemical composition of materials are to be verified by the RIQAL or QATB, as specified on the PR. Evidence of the following required supplier's inspections and tests, if applicable, are to be verified during receiving inspection:

a. Material certification test report.

b. Evidence of supplier inspection acceptance.

c. Certification that end-items is from material furnished.

d. Test data.

e. Inspection reports.

f. Other documentation as specified in the PR.

Verification coupons, if required, are to be spectrochemically analyzed to verify their composition. Heat-treated materials are to be hardness tested to verify specified heat treatment.

Fasteners (including bolts/nuts, screws, washers, rivets, and welding rods) are to be verified from lot samples as specified by the RIQAL or QATB, as specified on the PR. Any fastener identified as “fracture critical” is to be verified at 80 percent of its specified yield strength.

7.5.3 Rejection of Received Articles

Articles which do not conform to drawings, specifications, or purchase order acceptance criteria or do not have adequate or correct data are to be documented in the LaRC Nonconformance Failure Report (NFR) Web System, and held for MRB disposition (see Chapter 7.8).

7.5.4 Responsibilities

The Receipt Inspection and Quality Assurance Laboratory (RIQAL) is responsible for:

a. Verifying parts and materials received, as specified on the PR, comply with procurement specifications by performing mechanical testing, chemical analysis, microscopic examination, and destructive testing.

b. Documenting any nonconformance on a test report and reporting it to the PR requestor.

The Quality Applications Technology Branch (QATB) is responsible for:

a. Verifying parts and materials received, as specified on the PR, comply with procurement specifications by performing mechanical testing, chemical analysis, microscopic examination, and destructive testing.

b. Documenting any nonconformance on a test report and reporting it to the PR requestor.

Shipping and receiving personnel are responsible for:

a. Inspecting space product packages for external damage only.

b. Delivering undamaged packages to the RIQAL or QATB, as specified on the PR.

7.6 FABRICATION PLANNING

Fabrication, assembly, disassembly, test, and inspection operations of all space products and associated GSE performed at LaRC facilities are to be accomplished in accordance with LMS-CP-5640, “Fabrication.” Contractor sites or subcontractor sites must utilize approved drawings and a documentation system equivalent to that identified in this chapter.

7.6.1 Fabrication Work Request

A completed NASA Langley Form 133, “Fabrication Work Request,” (FWR) with Fabrication Representative (FR), the person receiving the work, approval, is required to initiate fabrication activities. All space product FWR's are to be marked as “Formal and signed by the requestor or project representative.

7.6.2 Fabrication and Inspection Operations Sheet

A NASA Langley Form 136, “Fabrication and Inspection Operations Sheet,” (FIOS) is to be prepared for each serialized part, group of parts or subassembly as per LMS–CP–5643, “Fabrication and Inspection Operations Sheet (FIOS) Administration Following Revisions, Operation Changes and Identification of Nonconformances.” All FIOS's require approval by the QATB QAS, the FR, and the requestor or the project representative.

7.6.3 Fabrication Processes

Process specifications are required for certain fabrication and assembly operations when any of the following conditions exist:

a. The final result or completion operation is not inspectable or testable.

b. The operation is sufficiently complex such that an experienced operator cannot successfully perform the operation with repeatable results.

c. The operation is potentially destructive to hardware or personnel.

d. The operation can generate destructive by-products, such as contamination, not apparent to the operator.

Existing proven processes (i.e., soldering, welding, heat treatment, coatings, etc.) are to be used on qualification and flight hardware and performed by qualified personnel.

All process specifications are to be submitted by the QATB QAS to the project rep for concurrence with adequacy and compliance to design requirements. Process documentation is to be available for review at the facility where the process is implemented. Processes are to be identified by number and revision and placed under configuration control.

7.6.4 Responsibilities

The Fabrication Representative (FR) will:

a. Review and approve the FWR.

b. Review and approve the FIOS.

The QATB Quality Assurance Specialist (QATB QAS) will:

a. Review and approve FIOS.

b. Identify QATB inspection points on the FIOS.

c. Verify required inspections are performed.

d. Assist the DPE in preparing the FIOS.

e. Assure all fabrication process steps are performed and signed off in sequence.

The Designated Project Engineer (DPE) will:

a. Initiate NASA Langley Form 133 “Fabrication Work Request.”

b. Prepare the FIOS.

c. Review and concur that process specifications are adequate and comply with design requirements.

7.7 HARDWARE IDENTIFICATION

7.7.1 Identification Number

Parts and assemblies are to be identified by an Identification (ID) Number consisting of a Part Number (PN) and a Serial Number (SN). Exceptions are as follows:

a. Parts which are permanently attached to other parts or assemblies (i.e., by welding, riveting, brazing, soldering, etc.).

b. Batch or lot controlled parts manufactured or processed in one operation do not require serial numbers.

c. Parts or assemblies specifically exempted as specified on drawings.

The PN identifies the LaRC drawing number from which the article was fabricated, the article drawing dash number, and the article drawing revision. A SN is added to the PN when like articles are to be manufactured with multiple operations.

The beginning SN, “001”, is to be assigned to the first article manufactured regardless of type (i.e., prototype, qualification unit, etc.) and will be consecutive through all configuration changes.

In general, the ID number sequence is illustrated as follows:

PN				SN
XXXXXXX	-	XXX	X	XXX
A	B	C	D	E

Where,

A = Seven figures (maximum) for identifying LaRC drawing number from which the article is fabricated.
B = Dash for separating article’s drawing number from its drawing dash number.
C = Three figures for article’s drawing dash number.
D = One letter noting article’s drawing revision (if drawing revision is not applicable, a dash will be used in lieu of a letter).
E = Three figures starting with “001” for the first of multiple parts and assemblies.

Example: 1023907-001A001

Fabrication technology personnel are to identify hardware as specified on engineering drawings. When no Identification (ID) Number is specified, the Tracking Number on the FIOS is to be used.

7.7.2 Identification Number Location

The ID Number is to be marked directly on the article, whenever possible, as follows:

a. Location of the ID Number on the article is to be specified on the article drawing.

b. The ID Number is to be legible after installation or assembly whenever possible.

c. The ID Number of assemblies is to be visible under normal vision and lighting conditions.

Articles having unsuitable or insufficient surfaces for direct marking (i.e., small springs, glass, plastic, optical elements, wire harnesses, etc.) or drawings which specify "NO MARKING PERMITTED" are to be identified by an ID Number on an attached identification tag (NASA Langley Form 183, "Hardware Identification Tag," or equivalent).

Articles which cannot be marked by other means, or where individual tagging is not practical (i.e., small electrical or electronic parts, attaching hardware, parts having dielectric properties, etc.) will be "bagged and tagged" as follows:

a. Articles are to be "bagged" in boxes, envelopes, bags, or other appropriate containers.

b. Containers are to be "tagged" by affixing an identification tag (Hardware Identification Tag NASA Langley Form 183 or equivalent)

Contents of the container are to be verified by a QATB QAS with appropriate quality stamping (see Chapter 7.9).

7.7.3 Identification Number Marking

The ID Number marking method (determined by contamination control requirements, size of the part, surface properties, etc.) is to be specified on drawings. Standard acceptable methods of marking are ink, electrochemical etching, chemical etching, and dot peening.

Dot peening, the preferred method, is a programmable marking system which utilizes a direct contact stylus. This method is capable of producing a wide variety of markings on all types of materials and surfaces.

Articles, which contain optical elements, subject to condensable volatile contamination, require special marking processes. These special processes shall be identified in the PAP.

Ink markings are to be applied directly on articles or identification tags with direct type stamps, indirect type stamps, or stencils available in small typeface (3/32" height) or

large typeface (1/8” height). Markem Ink Company 7224 ink, or equivalent, is to be used in white, black, or green colors. Identification tags shall be NASA Langley Form 183 or equivalent.

When a non-injurious method is required for permanent marking of bare metallic or conductive surfaces, electrochemical etching will be used in preference to ink marking. Electrochemical etching is accomplished by use of the LECTROETCH Company power unit, or equivalent, in accordance with the manufacturer’s recommendations (including electrolyte and cleaner specified) unless otherwise specified on drawings. The resulting etchings and the surrounding area are to be thoroughly cleaned to remove corrosive chemicals after use.

Etching depth is subject to operation variables. If the depth of the etch is critical (e.g., fatigue life), samples are to be prepared at various voltages and application duration to determine those variables necessary to achieve an acceptable depth of etch.

The ID Number marking for printed circuit boards is limited to chemical etching. The PN is chemically etched as part of the fabrication process. If more than one board of the same drawing is fabricated, the SN will be silk screened using glass baking epoxy ink (NAZ-DAR-BE-112 White or BE-111 Black). After application, the board is to be baked at 250 °F for one hour to cure the ink.

7.7.4 Identification Removal

Upon removing the articles for final use, the identification tag is placed in the appropriate logbook (see Chapter 7.11) and the ID Number recorded on NASA Langley Form 154, “Configuration Record,” by the OMA QAS.

7.7.5 Responsibilities

The Designated Project Engineer (DPE) is responsible for:

a. Providing the ID number, ID number location, and ID number marking method on engineering drawings.

Fabrication technology personnel are responsible for:

a. Marking and tagging of articles.

The QATB Quality Assurance Specialist (QATB QAS) is responsible for:

a. Verifying contents of “Bag and Tag” containers by quality status stamping identification tags.

The OMA Quality Assurance Specialist (OMA QAS) is responsible for:

4 Placing the identification tag in the appropriate logbook and recording ID Number on NASA Langley Form 154.

7.8 NONCONFORMANCE AND FAILURE REPORTING

Nonconformances and failures are required to meet specific reporting, disposition, documentation, verification, and close out requirements as specified below.

For purposes of this document, the following definitions apply:

a. Nonconformance - A condition or characteristic of any hardware or software item which does not conform to drawings or other specifications.

b. Failure - The inability of a system, subsystem, component, or part to perform in accordance with a specified functional test or operating requirement.

7.8.1 Reporting

All nonconformance and failures associated with space products are to be documented in the LaRC Nonconformance/Failure Reporting (NFR) Web System. The URL for the system is http://nfr .The help section of the web system will give instructions for the use of the system. The proper project personnel are added to the system as new projects are established by Office of Mission Assurance personnel. Passwords are obtained from the Office of Mission Assurance (OMA). Paper copies are to be printed from the Web system to be placed in work order packages and logbooks as required. The official records reside in the electronic database. A paper copy of the form can be used in the field if no access to the computer system is available but must be added to the database as soon as practical.

If the reported nonconformance or failure poses a safety hazard to personnel or equipment, operations are to be discontinued in an orderly manner. Operation will resume pending proper documentation and disposition of the nonconformance or failure as authorized by the Material Review Board (see 7.8.2).

7.8.2 Disposition

The cognizant engineer is only authorized to return the discrepant item for completion of work to be performed, return to supplier, or scrap. Other dispositions require the approval of a MRB. A project Materials Review Board (MRB) is to be established with authority to make dispositions. The project MRB is a technical team comprised of the DPE, QATB QAS/OMA QAS, and a representative from project management. The OMA/ QAS is to maintain a current list of MRB membership and other technical experts as appropriate. For NFR's dispositioned by QATB, the project representative and the DPE may be the same person.

All NFR dispositions are to be compatible with specified design, performance, interface, reliability, and safety requirements and evaluated for impact upon costs and

schedules. Unanimous agreement by the MRB is required to a make disposition. If unanimous agreement cannot be reached, the Project Manager is to authorize an appropriate disposition. The designated QATB QAS/OMA QAS has the authority to defer any disposition to the Head, OMA, if unable to concur with the disposition.

7.8.3 Documentation

All NFR's generated during the fabrication process are to be logged and maintained on the appropriate FIOS. A paper copy of all NFR's generated will be included in the Work Order Package.

NASA Langley Form 146, "Nonconformance-Failure Report (NFR) Summary," is to be maintained in all component, subsystem, and system logbooks. It will list all NFR's generated after fabrication. A paper copy, printed from the NFR Web system, for each NFR is to be included in the logbook. Logbooks are to be maintained by the DPE.

7.8.4 Verification and Closeout

The completion of all quality actions and dispositions require verification by the designated QAS/QAR to close an NFR. The OMA QAS will verify closure of all NFR's. A paper copy of the NFR is to be printed from the Web system and maintained in the project logbooks.

7.8.5 Responsibilities

The originator of a NFR will:

a. Complete Part A of NASA Langley NFR web form. Distribution to the Designated Project Engineer by e-mail will occur once Part A has been completed and approved.

The Designated Project Engineer (DPE) will:

a. Make technical decisions and recommendations for disposition compatible with design/performance requirements, specifications, reliability, and safety.

b. Complete Part B of NASA Langley NFR Web form or convene the MRB.

c. Provide appropriate details of engineering analyses as required or as requested by other MRB members.

d. Prepare necessary detailed instructions for implementing disposition activities directed by the MRB on Part C of NASA Langley NFR Web form

e. Approve MRB disposition on Part D of the NFR Web form.

The QATB QAS or OMA QAS will:

a. Assure that reliability, quality, and safety is adequately considered in determining the disposition of the NFR.

b. Approve Part D of the NASA Langley NFR Web form to indicate concurrence with the MRB disposition.

c. Verify that dispositions are satisfactorily completed for closeout, Part E of NASA Langley Web form.

d. Defer to next highest level of line management if unable to concur with any NFR disposition considered incompatible with design/performance requirements, interface specifications and/or quality/reliability requirements, or considered beyond scope of responsibility.

e. QATB QAS will perform above functions for all NFR's generated during fabrication of space flight hardware.

The OMA QAS will:

a. Maintain current list of MRB membership.

b. Enter Project data into the NFR Web system as required for existing or new projects.

c. Perform final closeout of all NFR's on the Web system.

d. Participate in MRB actions as required.

e. Defer to Project Manager if unanimous agreement cannot be reached by the MRB.

The Project Manager (PM) will:

a. Insure the project adheres to the NFR requirements.

b. Participate in MRB dispositions as required.

c. Arbitrate MRB action when unanimous agreement cannot be reached. Approve part D of MRB as required.

d. Assign project representative when deemed necessary.

The Project Representative will:

a. Represent the Project Manager as requested.

b. Perform all duties of the project manager as directed with the exception of approving MRB activities when a unanimous agreement cannot be reached.

7.9 QUALITY STATUS STAMPS

Quality Status Stamps (QSS) provide functional accountability for the quality status of products through the identification of quality assurance personnel by number. Every stamped impression is to be accompanied by a handwritten date. QSS are required to meet specific criteria, application, procedures, and issuance and control.

An authorized QSS user log will be maintained by OMA. Inappropriate and unauthorized use of stamps could lead to disciplinary action.

QSS are to be utilized as the means of verifying quality status of space related products, documentation, containers, and other articles as follows:

a. Conformance Stamp - A triangular shaped stamp used to indicate that items satisfy requirements and conform to prescribed criteria.

b. Nonconformance Stamp - A hexagonal shaped stamp used to indicate that items have been inspected and/or tested, but do not conform to requirements. Such items are subject to further corrective actions, inspections, tests, investigations, processing, or contract action.

c. Void Stamp - A “D” shaped stamp used to indicate that previous inspections, tests, and accompanying documents are void.

7.9.1 Quality Status

Quality status is to be controlled and maintained as follows:

a. All independent entries, steps, tasks, etc. delineated on equipment history records, test procedures, fabrication work documents, etc., satisfactorily accomplished and witnessed, inspected and/or verified by QA personnel are to be “CONFORMANCE” stamped.

b. When any previously stated condition is unsatisfactory or nonconforming, it is to be “NONCONFORMANCE” stamped and identified by referring to an NFR.

c. Whenever a previously accepted entry, step, task, etc. no longer conforms to requirements, it is to be voided by using a “VOID” stamp interlocking to the right of the original “CONFORMANCE” stamp. An assembly history note is to be written to refer to the report, which documents the reason for voiding.

d. When the reasons for voiding are corrected, a “CONFORMANCE” stamp is applied to the right of the “VOID” stamp.

e. “NONCONFORMANCE” stamps are cleared (overridden or superseded) by the placement of a “CONFORMANCE” stamp to the right of and interlocking with the “NONCONFORMANCE” stamp.

7.9.2 Application

QSS may be applied directly to hardware, except when the quality of the article would be degraded by the direct application of ink and/or the size or shape of the article would preclude direct application. In such instances, QSS are to be applied to the related documentation.

7.9.3 Procedures

Accepted LaRC QSS procedures are as follows:

When a part permanently marked for “TEST USAGE” is returned for completion of operation by a MRB action, the accompanying documentation is to be "NONCONFORMANCE” stamped and the NFR number is to be permanently marked next to the test usage marking as indicated:

TEST USAGE ONLY
NFR 4488

All written entries, requiring QSS for validation, are to be in ink.

Apply QSS to documentation upon completion of inspection.

Apply only one stamp for each acceptance or rejection.

Date all stamped entries when applied.

If any additional written entry is made after validation by QSS, all related subsequent test and inspection points previously validated are to be “VOID” stamped.

To cancel a QSS impression made in error, it is to be “VOID” stamped across the face of the erroneous impression and dated with stated reason for canceling.

To indicate partial inspection conformance of an article or a test, apply the QSS to the left of the “Acceptance” block on the applicable record and denote existing condition, which requires subsequent inspection. If and when the inspection has been completed, the QSS can be moved into the “Acceptance” block.

When an erroneous data entry has been made on an inspection record, draw a single line through it. Enter the correct information and apply the QSS and date next to correction.

Interlock QSS from left to right to indicate the sequence in which the stamping occurred.
QSS are to be applied to the container or tags attached to the bag or bundle for accepted articles such as “O” rings, fasteners, connectors, packaging materials, electrical and electronic components, and optical components.

Stamped containers or tags are not to be separated from items prior to installation.

7.9.4 Issuance and Control

QSS are to be traceable to the individual responsible for verifying the quality of the items as follows:

a. NASA Langley Form 142, “Quality Status Stamp Request Receipt,” is to be used for requesting and acknowledging receipt of a set of QSS.

b. NASA Langley Form 450 “Quality Status Stamp Control,” is to be used for inventory, reporting lost or damaged QSS, and notification of employment termination.

c. Only one set of the three QSS (one stamp of each design and size) is to be assigned to a given individual.

OMA is to maintain a control system for the traceability of QSS by performing the following:

a. Issue QSS sets and record names of individuals to whom sets are issued.

b. Issue replacement QSS when worn or damaged.

c. Control re-issue of QSS upon termination or transfer of personnel (QSS numbers are to be withheld from use for a period of one year before reissue to another individual).

d. Record lost QSS and investigate circumstances.

e. Perform inventory and verify records, at least once a year, of all QSS issued and in stock.

f. If QSS are no longer required, they must be returned.

QSS assignees are to complete NASA Langley Form 450 for the following:

a. Annual inventory of QSS.

b. Reporting lost or damaged QSS.

c. Notification of employment termination.

7.9.5 Responsibilities

The Office of Mission Assurance (OMA) is responsible for:

a. Maintaining a control system for quality status stamps.

b. Issuing stamp sets and recording names of individuals to who stamps are issued.

c. Issuing replacement stamps.

d. Controlling reissue of stamps upon termination or transfer of personnel.

e. Recording lost stamps and investigating circumstances.

f. Inventorying, at least once a year, stamps issued and in stock, including verification of records.

Quality status stamp requesters are responsible for:

a. Completion of request portion of NASA Langley Form 142 and mailing to the Head, OMA, Mail Stop 429.

b. Completion of receipt portion of NASA Langley Form 142 when accepting quality status stamps.

Quality status stamp assignees are responsible for completion of NASA Langley Form 450 for:

a. Annual inventory of quality status stamps.

b. Reporting lost or damaged stamps.

c. Notification of employment termination.

d. Perform QSS as outlined in this chapter.

7.10 BONDED STORES

Bonded stores are to be established as per LMS-CP-4892, “Bonded Storage,” when assembling space flight hardware that must be closely controlled to ensure safety and product quality. The objective of bonded stores as established by LMS-CP-4892 is to provide control and accountability of materials, hardware, and associated equipment used to build LaRC’s products, thereby ensuring safety, reliability, and functionality.

7.11 LOGBOOKS

Logbooks shall be used to provide traceability and verification of hardware, software, and associated GSE during assembly, test, and launch operations. The logbook will provide a record of work, inspections, and NFR's. QSS are to be used when making entries in logbooks. As a minimum, logbook entries are to chronologically contain date, time, description of event or activity and name of individual performing the activity. Logbooks are to remain within the designated work area or with the assigned hardware.

7.11.1 Issue

Project personnel are required to obtain and maintain appropriate logbooks from the OMA QAS when two or more parts are to be assembled after release from the QATB. The assigned QAS is to issue and maintain accountability of all logbooks and assure logbooks are maintained current by the requester.

7.11.2 Component Logbook

A Component Logbook is to be issued when two or more parts are assembled which perform a distinctive function.

Component Logbooks are to contain the following:

a. NASA Langley Form 132, "Record of Weight," entered as generated.

b. NASA Langley Form 138, "Time/Cycle Log."

c. A paper copy of the "Nonconformance-Failure Report (NFR)" entered as generated.

d. NASA Langley Form 146, "Nonconformance Failure Report (NFR) Summary."

e. NASA Langley Form 154, "Configuration Record," maintained current.

f. NASA Langley Form 155, "Assembly History Record," containing entries for all activities performed on the component including assembly, test, calibration, disassembly, etc.

g. "As-Run" assembly and test procedures.

Component Logbooks are to remain with the hardware until integration of the component into the next level of assembly. Any open NFR's are to be transferred into the Subsystem Logbook. After integration is complete, Component Logbooks are to be stored in a centrally accessible location until completion of the project.

7.11.3 Subsystem Logbook

A Subsystem Logbook is to be issued when components or parts are assembled to form a major functioning entity within a system (i.e., ignition, fluid, radar, etc.). This logbook integrates the appropriate Component Logbooks into one logbook and provides a record of work, inspection, and NFR's incurred during assembly and test of the subsystem.

Subsystem Logbooks are to contain the following:

a. NASA Langley Form 132, "Record of Weight," entered as generated.

b. NASA Langley Form 138, "Time/Cycle Log," continued from the Component Logbook.

c. A paper copy of the "Nonconformance-Failure Report (NFR)" entered as generated.

d. NASA Langley Form 144, "Connector Log."

e. NASA Langley Form 146, "Nonconformance Failure Report (NFR) Summary," continued from Component Logbook.

f. NASA Langley Form 154, "Configuration Record," continued from the Component Logbook.

g. NASA Langley Form 155, "Assembly History Record," continued from the Component Logbook.

h. "As-Run" assembly and test procedures.

Subsystem Logbooks are to remain with the hardware until integration of the subsystem into the system. Any open NFR's are to be transferred into the System Logbook. After integration is complete, Subsystem Logbooks are to be stored in a centrally accessible area until completion of project.

7.11.4 System Logbook

A System Logbook is to be issued when subsystems are integrated into one of the principal functioning entities comprising the hardware, software, and related operational services within a project or flight mission (i.e., thermal protection, propulsion, control, etc.). This logbook integrates the appropriate Subsystem Logbooks into one logbook and provides a record of work, inspection, and NFR's incurred during assembly and test of the system.

System Logbooks are to contain the following:

a. NASA Langley Form 132, “Record of Weight,” entered as generated.

b. NASA Langley Form 138, “Time/Cycle Log,” continued from the Subsystem Logbook.

c. NASA Langley Form 139, “Removal/Installation Log,” initiated only after completion of system integration.

d. A copy of the “Nonconformance-Failure Report (NFR)” entered as generated.

e. NASA Langley Form 144, “Connector Log,” continued from the Subsystem Logbook.

f. NASA Langley Form 146, “Nonconformance Failure Report (NFR) Summary,” continued from the Subsystem Logbook.

g. NASA Langley Form 154, “Configuration Record,” continued from the Subsystem Logbook.

h. NASA Langley Form 155, “Assembly History Record,” continued from the Subsystem Logbook.

i. “As-Run” assembly and test procedures.

System Logbooks are to remain with the DPE until archived with other project documentation.

7.11.5 GSE Logbook

A GSE Logbook is to be issued when any GSE is required during assembly, test, and launch operations. This logbook is to provide a record of work, inspection, and NFR’s incurred during use of the GSE. The GSE logbook is to remain with the equipment throughout its use.

GSE Logbooks are to contain the following:

a. A copy of the “Nonconformance-Failure Report (NFR)” entered as generated.

b. NASA Langley Form 146, “Nonconformance Failure Report (NFR) Summary.”

c. NASA Langley Form 154, “Configuration Record.”

d. NASA Langley Form 155, “Assembly History Record.”

e. Calibration and maintenance records.

f. Handling and lifting equipment certifications.

7.11.6 Numbering System

All logbooks are to be identified and numbered on NASA Langley Form 184, “Logbook Identification Card”. Logbook numbers are to consist of the first three letters of the project name, a sequential three-digit number beginning with “001” and a three-letter abbreviation denoting the type of logbook as follows:

a. COM - Component Logbook.

b. SUB - Subsystem Logbook.

c. SYS - System Logbook.

d. GSE - GSE Logbook.

Example: HAL-001-COM.

7.11.7 Responsibilities

Project system/subsystem managers and other designated project personnel will:

a. Request appropriate logbooks from OMA.

b. Maintain required logbooks.

The Office of Mission Assurance (OMA) will:

a. Issue and maintain accountability of all logbooks.

b. Conduct periodic audits to assure logbooks are properly maintained.

7.12 ASSEMBLY AND INTEGRATION

All space product and associated ground support equipment are to be assembled or disassembled using approved drawings and/or procedures. All assembly or disassembly is to be verified by OMA personnel. OMA personnel are to be present during all critical inspection activities identified in the assembly procedure.

7.12.1 General

Line organization engineers and technicians are to be assigned to each space project for the purpose of planning and conducting activities within their jurisdiction.

When more than one line organization is involved in the assembly, the project manager is to provide overall coordination of organizations. Organizational guidelines are to be utilized to the maximum extent possible when preparing assembly plans and procedures.

When a nonconformance or failure is encountered which poses a safety hazard to personnel or space flight hardware, the affected procedure or operation is to be discontinued in an orderly manner. Any resumption of a discontinued operation is to be accomplished using approved documented procedures.

All equipment used in assembly (i.e., torque wrenches, voltmeters, etc.) are to be in current calibration.

Handling and lifting GSE (i.e., slings, hoists, tables, carts, etc.) are to be certified in accordance with applicable safety requirements of the assembly facility. Evidence of current calibration shall be visibly affixed.

Project logbooks are to be initiated and maintained during assembly of all space products and GSE.

7.12.2 Assembly Procedures

Project personnel shall generate an assembly procedure when the drawing does not provide adequate detail for assembly. The assembly procedure shall outline the scope, technical intent, and equipment required and detailed assembly instructions. The assembly procedure is to be submitted to OMA for approval.

7.12.3 Procedures

All assembly or disassembly is to be performed in accordance with written procedures approved by the PAM. The degree of detail is to be sufficient to clearly convey information needed for the performance of all tasks.

Procedures are to include, but are not limited to, the following:

a. Cover sheet

b. Approval “signoff” page

c. Personnel required to accomplish the task.

d. Detailed Objectives.

e. Item description and identification.

f. Facility environmental requirements, cleanliness category, etc.

g. Reference documents, specifications, drawings, schematics, etc.

h. Hardware configuration list.

i. Video and/or photographic requirements.

j. List of required equipment.

k. Sequential detailed steps describing the task to be preformed with signature and dateline to be completed by individual performing task.

l. Tasks potentially hazardous to personnel or equipment are to be pre-approved by designated safety personnel. These tasks are to be preceded by a warning or caution note easily distinguishable from other text.

m. Tasks requiring inspection or verification are to be quality stamped and dated by appropriate QAS.

Changes to approved procedures may be “red lined”, but must be initialed and dated by the DPE and QAS.

7.12.4 Responsibilities

Designated Project Engineer (DPE) is responsible for:

a. Preparing the individual procedures.

b. Approving “red lines” to drawings and procedures.

Office of Mission Assurance (OMA) personnel are responsible for:

a. Review and approval of all assembly procedures.

b. Verification and signoff of procedures.

c. Verification of calibration/certification of handling and lifting GSE.

d. Maintaining safety oversight of procedures.

Facilities personnel are responsible for:

a. Performing tasks outlined in procedures and on drawings.

7.13 TESTING

Functional and environmental testing of space products and associated GSE, for purposes of flight acceptance, are to be conducted according to written and approved plans and procedures. All testing activities are to be verified by OMA personnel. OMA personnel are to be present during all critical inspection activities identified in the Integrated Test Plan (ITP).

7.13.1 General

Line organization test engineers and technicians are to be assigned to each space project for purposes of planning, scheduling, and conducting test activities within their jurisdictions. When more than one line organization is involved in the conduct of testing activities, a project test manager is to be designated by the project manager to provide overall coordination of project related testing activities. Organizational guidelines are to be utilized to the maximum extent possible when preparing test plans and procedures.

All equipment used in testing (i.e., scopes, power supplies, torque wrenches, etc.) is to be in current calibration. All software used for test and measurement purposes is to be in a known and controlled configuration.

Handling and lifting GSE (i.e., slings, hoists, tables, carts, etc.) are to be certified in accordance with applicable safety requirements of the test facility. Evidence of current certification shall be visibly affixed.

Project logbooks, initiated during the initial assembly phase, are to be maintained during testing operations.

7.13.2 Integrated Test Plans

Project personnel shall generate an Integrated Test Plan (ITP). The ITP shall outline the scope, technical intent, and success criteria of the overall project-testing program. The ITP is to be submitted to OMA for approval. Requirements and conditions necessary to accomplish component, subsystem, system, payload, GSE, and associated software testing, as appropriate, are to be included in the ITP.

As a minimum, the following are to be provided for each test:

a. Overall test objectives.

b. Overall test requirements.

c. General testing rules.

d. Test sequence flow diagram.

e. Summary matrix (indentured list of test items versus the type of test in each category).

f. Identification of organizations responsible for the development, implementation, and approval of test plans, specifications, and procedures.

g. Description of test facilities and major support equipment.

h. Disposition of test data.

i. QA requirements.

7.13.3 Procedures

All testing is to be performed in accordance with written procedures approved by the PAM. The degree of detail is to be sufficient to clearly convey information needed for the performance of all tasks.

Procedures are to include, but not limited to, the following:

a. Cover sheet (with title, date, and test number).

b. Approval “sign-off” page.

c. Telephone numbers of designated personnel to be contacted in an emergency.

d. Personnel required to accomplish test.

e. Detailed test objectives.

f. Test item description and identification.

g. Expected results with “pass/fail” criteria.

h. Data measurement, recording, and analysis requirements.

i. Facility environmental requirements, cleanliness category, power levels, etc.

j. Reference documents, specifications, drawings, layouts, schematics, etc.

l. Hardware and software configuration checklist.

m. Video and/or photographic requirements.

n. List of required equipment, including special purpose test equipment and simulator software, with provisions for recording serial numbers, calibration due dates, and software version numbers.

o. Sequential detailed steps describing the task to be performed with signature and date line to be completed by individual performing task (includes setup of special equipment, entry of parameters into software tables, and preliminary calibrations and operational checks).

p. Tasks potentially hazardous to personnel or equipment are to be pre-approved by designated safety personnel. These tasks are to be preceded by a warning or caution note easily distinguishable from other text.

q. Tasks requiring inspection or verification are to be quality stamped and dated by the appropriate QAS.

r. Tasks requiring manual recording of data are to include a formatted table or chart such that the expected values and allowable tolerances are adjacent to the data being recorded.

s. Detailed sequential steps for all identified emergency “shut-down” conditions.

Changes to approved procedures may be “red-lined”, but must be initialed and dated by the DPE and QAS.

When a nonconformance or failure is encountered which poses a safety hazard to personnel, test equipment, or space flight hardware, the affected procedure or operation is to be discontinued in an orderly manner. Any resumption of a discontinued test is to be accomplished using approved documented procedures.

7.13.4 Reporting

On completion of each test (including failed and aborted tests), the test engineer prepares a copy of a Quick-Look Test Report (QLTR) to be forwarded to the project manager. The QLTR consists of a test objectives and results summary, any assigned open issues (with dates of expected resolution), and the “as-run” test procedure.

Once determination is made that the test objectives were satisfied, a Final Test Report (FTR) is to be prepared and forwarded to the project manager. The FTR will describe in detail the degree to which objectives were satisfied, how well the mathematical models were validated, and other pertinent test related information as follows:

a. A chronological listing of the significant activities and related events that occurred during the performance of the test.

b. Detailed discussions of any procedural changes and failures.

c. Data generated by the test.

d. Status and reporting plans for performance data.

e. Post-test status of test article.

f. Changes to test article during test.

g. Listing of NFR's.

h. List of authorized activities (i.e., troubleshooting) not originally planned, with approved procedures.

i. Copy of the "as-run" test procedure.

7.13.5 Responsibilities

Project personnel are responsible for:

a. Preparing the ITP and individual test procedures.

Test Engineer is responsible for:

a. Performing the test in accordance with the procedures.

b. Preparing the Quick-Look Test Report.

c. Preparing the Final Test Report.

Office of Mission Assurance (OMA) personnel are responsible for:

a. Participating in test operations to monitor or witness as necessary to verify compliance to approved procedures.

b. Verifying current calibration and/or certification of handling and lifting GSE.

The Product Assurance Manager (PAM) is responsible for:

a. Approving test procedures.

7.14 ELECTROSTATIC DISCHARGE (ESD)

The transfer of an electrostatic charge (static electricity) between bodies at different electrostatic potentials, caused by direct contact or induced by an electrostatic field, is termed an electrostatic discharge (ESD). Certain electrical and electronic parts (i.e.,

microelectronic and semiconductor devices, thick and thin film resistors, chips and hybrid devices, piezoelectric crystals, etc.) are sensitive to the damaging effects of ESD. This damage can manifest itself immediately or in the future as a latent defect. Many failures of undetermined origin are probably a result of ESD. Assemblies and equipment containing these parts are also susceptible to damage when an ESD occurs at their terminals or when they are exposed to electrostatic fields.

Electrical and electronic parts, assemblies, and equipment sensitive to ESD voltages of 15,000 volts or less are to be designated as ESD sensitive (ESDS) and identified as such on drawings and parts lists. ESDS items are to be designed and handled in accordance with NASA-STD-8739.7, “Electrostatic Discharge Control (Excluding Electrically Initiated Explosive Devices)”.

7.14.1 Design

Protection against ESD is to be considered when designing electrical circuits. Design techniques are to be utilized which reduce the susceptibility of parts and assemblies to ESD.

7.14.2 Handling

Personnel handling ESDS items shall be trained and certified in ESD precautionary measures in accordance with NASA Standard 8739.7. Precautions are to be taken throughout the life cycle of ESDS devices to prevent damage during handling, packaging, inspection, shipping, storage, assembly, testing, installation, or maintenance.

The following precautions, as a minimum, are to be employed while handling ESDS devices:

a. All ESDS devices are to be stored or transported in anti-static material, preferably with the exposed leads at a common potential.

b. Prior to removing ESDS devices from anti-static material, the device is to be placed on an anti-static work surface.

c. A conductive wrist strap, tied to a soft ground common to the work surface, is to be worn by the operator. Personnel without a wrist strap are to be restricted from the ESDS area.

d. Tools are to consist of conductive or static dissipative materials.

e. Equipment used in an ESDS area is to be grounded.

f. Soldering operations are to be performed using a grounded tip soldering iron.

g. Materials that are prime generators of ESD (i.e., common plastics such as polyethylene, polystyrene foam, polyurethane, vinyl, foam, synthetic textiles, fiberglass, glass, and rubber, etc.) are to be removed.

h. Direct contact between street clothing and ESDS devices is to be avoided.

7.14.3 Work Stations

ESDS items, when removed from their protective packaging, are to be handled with ESD protective devices only at an ESD workstation. The QAS will use diagnostic equipment to verify that personnel and space products are properly grounded when ESDS items are removed from their protective packaging during payload build-up.

As a minimum, a typical workstation will consist of the following items:

a. Personnel ground strap.

b. ESD protective work surface.

c. Air ionizer.

d. Humidity control.

e. ESD caution signs.

7.14.4 Responsibilities

Project personnel will:

a. Consider ESD protection in designs.

The technicians are responsible for:

a. Complying with the ESD requirements.

The OMA Quality Assurance Specialist (OMA QAS) will:

a. Assure compliance with ESD requirements.

b. Assure personnel are properly certified as per NASA Std. 8739.7.

7.15 CONTAMINATION CONTROL

The PAP shall require the submittal of a Contamination Control Plan (CCP) to OMA for approval. The CCP will specify the cleanliness and environmental conditions

required during the assembly, test, transport and operation of space products to maintain the desired level of cleanliness. In addition, all space products flown on the National Space Transportation System (NSTS) or the International Space Station (ISS) are to comply with the respective cleanliness levels.

Clean rooms are defined as enclosed areas employing temperature, humidity, and pressure controls for control of airborne particulate matter, molecular contamination, and volatile residues.

Clean work stations are defined as work benches or similar working enclosures characterized by having their own filtered air supply.

All clean rooms and clean workstations are to comply with the following standards for their designated classification.

7.15.1 Class 100 Clean Room/Work Station

Requirements for contamination control of Class 100 clean rooms and workstations are as follows:

a. No particles over 4.0 microns are permitted.

b. Total particle count is not to exceed 100 particles of a size .5um or larger per cubic foot.

c. For particles 0.5 micron and larger, equipment employing light scattering principles is to be used for measurement.

d. Measurement equipment is to provide particle quantity and size data.

7.15.2 Class 10,000 Clean Room/Work Station

Requirements for contamination control of Class 10,000 clean rooms and workstations are as follows:

a. No particles over 35 microns are permitted.

b. Total particle count is not to exceed 10,000 particles of a size .5um or larger per cubic foot.

c. For particles 0.5 micron and larger, equipment employing light scattering principles is to be used for measurement.

d. Microscopic counting of particles collected on a membrane filter, through which a sample of air has been drawn, may be used for measurement of particles 5.0 microns and larger.

e. Measurement equipment is to provide particle quantity and size data.

7.15.3 Class 100,000 Clean Room/Work Station

Requirements for contamination control of Class 100,000 clean rooms and workstations are as follows:

a. No particles over 100 microns are permitted.

b. Total particle count is not to exceed 100,000 particles of a size .5um or larger per cubic foot.

c. For particles 0.5 micron and larger, equipment employing light scattering principles is to be used for measurement.

d. Microscopic counting of particles collected on a membrane filter, through which a sample of air has been drawn, may be used for measurement of particles 5.0 microns and larger.

e. Measurement equipment shall provide particle quantity and size data.

7.15.4 General Operations

The organizations responsible for the operation of clean rooms/work stations shall conduct appropriate training classes for all personnel using their facilities. Certification of completed training shall be provided.

Compliance with the following provisions is essential for the successful operation of clean rooms and workstations:

a. Equipment used to control, monitor, and record clean room and clean workstation conditions is to be calibrated as specified by the manufacturer.

b. All equipment is to be cleaned and decontaminated before being passed into the clean environment by dusting, vacuuming, washing, dunking, or other suitable means compatible with the equipment involved.

c. Environmental conditions such as temperature and humidity are to be controlled, continuously recorded, and reviewed as specified. Noise levels should be kept as low as possible for personnel comfort. However, a maximum noise level of 85 dBA is not to be exceeded without proper protection and controls.

d. An air pressure of 0.05 inches of water above that of surrounding areas is to be maintained in clean rooms to assure an outward flow of air.

e. Gloves, tweezers, or other mechanical barriers to prevent contact between skin and hardware are to be used while working with or handling sensitive parts.

f. Exhaust systems for grinding, welding, soldering, machining, or other related operations are to be installed in accordance with the “Industrial Ventilation Manual” published by the American Conference of Government Industrial Hygienists.

g. Equipment used to maintain the cleanliness of the clean area is to be stored within the clean area in a manner to prevent accumulation or dispersion of particulates or microbiota on the surfaces.

h. Vacuum hoses, electrical cables, and other flexible conductors are to be stored on reels or racks off the floor of the clean room. Use of bristle brushes, steel wool, and other particle shedding material is not permitted.

7.15.5 Responsibilities

The Project Manager (PM) is responsible for:

a. Establishing the level of cleanliness requirements.
b. Developing the CCP.

The Product Assurance Manager (PAM) will:

a. Review and approval the CCP.

The OMA Quality Assurance Specialist (OMA QAS) will:

a. Audit to ensure compliance with the CCP.

The line organization responsible for the operation of clean rooms/work stations will:

a. Conduct appropriate training classes for all personnel using their facilities.
b. Provide certification of completed training.
c. Maintain the specified levels of cleanliness.

7.16 INTEGRATED DATA PACKAGE

7.16.1 General

An Integrated Data Package (IDP) is to be provided at the point of delivery to an integrated test facility or launch site, which documents the configuration, functional characteristics, and flightworthiness of all deliverable space products, GSE, and associated spares.

The IDP shall comply with all integrated test facility or launch site specific requirements.

The IDP will reflect the status of each applicable hardware and software item at the time of the Systems Acceptance Review (SAR) and is to be delivered concurrent with the hardware and software.

As a minimum, the following is to be included in the IDP:

a. Index of included items.

b. Notes/Documents (customer's option).

c. All Deviations/Waivers (both open and closed).

d. List of shortages.

e. Closed NFR's affecting LaRC.

f. Open NFR's affecting integration activities.

g. Listing of unplanned/deferred work.

h. Identification (as-built configuration/drawings).

i. Limited operating life/age sensitive items.

j. Pyrotechnic data.

k. All installed non-flight items identified.

l. Current certification of proof-load and calibration of GSE to be turned over.

m. Operating test procedures.

n. List of open items from Phase III Ground Safety Review (see Chapter 8.6.1).

7.16.2 Responsibilities

The Project Manager (PM) will:

a. Identify and compile documentation for incorporation into the IDP.

The Office of Mission Assurance (OMA) will:

a. Assist the PM in establishing the IDP requirements for LaRC-fabricated space-flight hardware and GSE.

b. Prepare the IDP requirements jointly with project system/subsystem manager for space-flight hardware contracts.

c. Review the IDP for compliance with requirements of this instruction.

d. Participate in the preparation of the IDP.

7.17 HANDLING, PRESERVATION, AND SHIPPING

Handling, Preservation, and Shipping of Space Flight Hardware is to be in accordance with LMS-CP-4756, “Handling, Preservation, Storage, and Shipping of Space Flight Hardware.” Hazardous material handling, preservation and shipping shall also follow applicable LMS-CP-4759 requirements.

The PAP is to specify requirements for the handling, preservation, and shipping of all space-flight products. Implementing instructions are to be identified on drawings and/or procedures.

7.17.1 Handling

Special handling instructions (e.g., ESDS items) are to be provided for items during all phases of fabrication and processing when requirements of standards are not sufficient.

Evidence of proof load testing is to be attached to handling equipment such as slings, hoists, cables, carts, etc. Handling equipment is to be in compliance with specified site requirements.

7.17.2 Preservation

Protective measures are to be identified and implemented to prevent deterioration from potentially damaging environmental conditions such as moisture, molecular and attached particulates, condensable volatiles, salt spray, sunlight, and temperature.

Additional protective measures are to be identified and implemented to prevent contamination of optics from anti-static packing materials.

7.17.3 Shipping

All items to be shipped are to be classified and identified on NASA Langley Form 52, "Shipping/Transfer Document." Packaging procedures for hazardous materials are to be approved by the DPE, OMA QAS, and the LaRC Safety Manager. Procedures for packaging pyrotechnics require the additional approval of the LaRC Pyrotechnic Support Engineer. ESDS items are to be packaged and shipped in approved ESD protective material.

7.17.4 Storage

Articles and materials to be stored are to be protected against deterioration and damage. Items requiring special internal environments, such as inert gases, to prevent degradation are to be identified and maintained accordingly. Containers are to be labeled with appropriate warnings (i.e., CAUTION-HAZARDOUS MATERIAL, GLASS, THIS END UP, FRAGILE, HANDLE WITH CARE, etc.).

Packaged articles are to have an affixed packing list containing the name and identification number of contents.

7.17.5 Responsibilities

The Project Manager (PM) is responsible for:

a. Preparing NASA Langley Form 52 and obtaining the necessary approvals.

b. Determining the appropriate "levels of packaging and classes of shipping" required for compliance with NPR 6000.1, "Requirements for Packaging, Handling, and Transportation … Equipment and Associated Components."

c. Identifying the handling, preservation, packaging, shipping, and storage requirements on drawings or procedures.

The OMA Quality Assurance Specialist (OMA QAS) is responsible for verifying:

a. Procedures and instructions are in compliance with established requirements.

b. The IDP is complete and the inspection status is identified by appropriate QSS.

c. The article is traceable to the "as-built drawing" and any open items are identified.

d. All articles and materials are properly identified and marked.

e. Articles and materials are prepared and packaged in accordance with written and approved procedures and instructions.

f. NASA critical item labels are affixed to the shipping containers.

g. Shipment routing and routing requests include special handling and monitoring instructions.

Chapter 8

SYSTEM SAFETY

8.1 GENERAL

This chapter identifies the plans; analyses, documentation, and reviews required for the identification and disposition of payload related hazards to ensure the protection of personnel, launch vehicles, flight hardware, GSE, and the environment.

The System Safety section of the PAP, for space products launched by both the National Space Transportation System (NSTS) and expendable launch vehicles (ELV's), shall be developed in accordance with the requirements of this chapter.

8.2 SYSTEM SAFETY PLAN

A System Safety Plan (SSP) shall be prepared for each space product by the integrating organization. Depending upon the size and complexity of the experiment, the SSP may be submitted under separate cover or included in the System Safety Section of the PAP. In all instances, the SSP requires OMA approval.

The SSP is to address the following items for the appropriate launch system and site:

a. Organizational responsibilities, authority, and interrelationships as related to system safety.

b. Orbital debris assessment. (See Section 5.5)

c. Required system safety analyses.

d. Internal and external safety review processes.

e. Hazardous operation surveillance.

f. Accident investigation and reporting.

g. Operator training and certification.

h. Required Safety Compliance Data Package documentation.

The PAM is to review and approve all procedures affecting space products, including hazardous operations, for compliance with identified system safety requirements and implementation in accordance with the PAP.

8.3 SAFETY COMPLIANCE DATA PACKAGE

A Safety Compliance Data Package (SCDP) is to be submitted to the applicable Safety Review Panel. If an established safety review process does not exist for a particular launch system or site, the PAM is to establish and implement an independent review process for the SCDP.

The SCDP is to provide information and data which assures all subsystem and system hazards have been identified, controlled by appropriate methods, and that control methods are verifiable.

The SCDP is to include the following for the appropriate launch system and site:

a. Mission overview.

b. List of applicable documents.

c. Payload description.

d. Safety overview.

e. Flight safety analyses with hazard reports.

f. Ground safety analyses with hazard reports.

g. Supplemental analyses.

h. Approved deviations and waivers.

i. Payload safety noncompliance reports.

8.4 FLIGHT SAFETY ANALYSIS

A Flight Safety Analysis (FSA) is to be prepared for space products and updated as the product progresses through design, fabrication, test, transportation, integration, and launch. The FSA is to include the following:

a. A description of the potential hazard.

b. Identification of the cause of the potential hazard.

c. The control or technical explanation demonstrating that the potential hazard does not pose a catastrophic or critical condition for the launch system.

d. Method of verification of control.

e. Current status of hazard control and verification.

A separate payload hazard report, similar to Johnson Space Center (JSC) Form 542, “Payload Hazard Report”, is to be generated for each specific hazard identified. NSTS payload “STANDARD HAZARDS”, with their appropriate controls, are identified on JSC Form 1230, “Flight Payload Standardized Hazard Control Report”.

8.5 GROUND SAFETY ANALYSIS

A Ground Safety Analysis (GSA) is to be prepared for each payload and its associated GSE when the use of a facility or the performance of an activity could result in subjecting facilities and/or personnel to hazards. The GSA is to include the following:

a. A description of the potential safety hazards to the flight hardware, GSE, facility, and personnel at the launch site.

b. Identification of the cause of the potential hazard.

c. The control or technical explanation demonstrating that the potential hazard does not pose a catastrophic or critical condition for the launch system.

d. Method of verification of control.

e. Current status of hazard control and verification.

8.6 NSTS PAYLOAD REVIEW AND APPROVAL PROCESS

8.6.1 Reviews

All safety reviews are to be held according to the following phased system:

a. Phase 0 - Requires potential hazards, hazard causes, and applicable safety requirements be identified and is held after the conceptual design has been established.

b. Phase I - Requires the methods of hazard control or elimination be provided and is held after the preliminary design has been established.

c. Phase II - Requires identification and status of the method for verifying implementation of hazard controls and is held after the final design has been established.

d. Phase III - Requires that all system safety actions have been satisfactorily closed out and is held upon completion of fabrication and testing prior to the SAR.

Any configuration change after the Phase III review process is to be reviewed and approved by the Safety Review Panel for possible hazards as a result of the change.

8.6.2 Approvals

All safety analyses are to be approved by safety review panels established and chartered by Johnson Space Center (JSC) and Kennedy Space Center (KSC) management. The cycle for this process is dependent upon the number of organizations involved.

8.7 ELV PAYLOAD REVIEW AND APPROVAL PROCESS

The guidelines, safety reviews, and approvals provided in this Section are applicable to both the Eastern and Western Ranges.

8.7.1 Launch Services and Mission Orientation Briefing

Launch Services and Mission Orientation Briefing (LSMOB) will be conducted for the Range Safety Organization approximately 45 days after project approval or contract award. The LSMOB will cover the following topics, as appropriate:

a. Changes to the launch vehicle.

b. Changes to the payload bus.

c. Planned payload additions for the mission.

d. Changes to hazardous systems and operations.

Range Safety concurrence for mission concept and proposed schedule will be provided within 14 days after briefing.

8.7.2 Flight Safety Data Package Review

A payload Flight Safety Data Package (FSDP) is to be delivered approximately 12 months prior to launch. The FSDP will contain data requirements identified during the LSMOB. Range Safety will provide responses within 45 days after receipt of the FSDP.

8.7.3 Ground Safety Data Package Review

A Ground Safety Data Package (GSDP) describing changes to approved operations and/or new or modified safety critical or hazardous procedures is to be delivered

approximately 120 days prior to payload arrival at the Range. Range Safety will provide responses within 45 days after receipt of the GSDP supplement.

8.7.4 Mission Approval Safety Review

A Mission Approval Safety Review (MASR) is to be conducted approximately 120 days prior to launch. The MASR will provide approval for the following activities:

a. Launch vehicle processing.

b. Payload processing.

c. Transport to payload launch pad.

d. Payload launch vehicle mating.

e. Launch pad payload processing.

Range Safety will typically provide mission safety approval within 14 days after review completion.

8.7.5 Final Launch Approval

Final approval to proceed with launch vehicle and payload processing up to beginning the final countdown will be provided by Range Safety at least 60 days prior to payload arrival at the launch complex.

8.8 Responsibilities

The Project Manager (PM) is responsible for:

a. The design of spacecraft and GSE hardware for compliance with agency flight and GSE and ground operations safety requirements as specified in the latest revisions of NSTS 1700.7, “Safety Policy and Requirements for Payloads Using the Space Transportation System” and KHB 1700.7, “Space Shuttle Payload Ground Safety Handbook” or EWR 127-1, “Eastern and Western Range Safety Requirements” for ELV launches on a national range.

b. Developing provisions for verifying safety requirements that are satisfied by inspection and/or tests.

c. Supporting the PAM in the coordination and preparation of required technical analyses.

d. Presenting technical discussions of safety analyses to the JSC and KSC safety review panels or the Eastern/Western Range.

e. Supporting OMA in post safety panel review activities.

The Product Assurance Manager (PAM) is responsible for:

a. Preparation of the SSP.

b. Preparation of the FSA, GSE and GOSA in accordance with NSTS 3830, “Implementation Procedure for NSTS Payload System Safety Requirements.”

c. Preparation of the SCDP.

d. Determination of the applicability of the requirements of NSTS 1700.7 and KHB 1700.7 for the payload/ experiment.

e. Serving as the single point of contact with the JSC and KSC Flight Safety Office representatives on safety related issues, and resolving any differences of interpretation of the requirements.

APPENDIX A

ACRONYMS

ANSI	American National Standards Institute
CC	Criticality Contribution
CCB	Change Control Board
CCP	Contamination Control Plan
CCR	Configuration Change Request
CDR	Critical Design Review
CI	Configuration Item
CIL	Critical Items List
CM	Configuration Management
CMOL	Configuration Management on Line
CMQP	Composite Material Qualification Plan
CO	Contracting Officer
COTR	Contracting Officer's Technical Representative
CP	Center Procedure
CSCI	Computer Software Configuration Item
DA	Delegated Agency
DD	Department of Defense
DIFtree	Dynamic Innovative Fault Tree
DPE	Designated Project Engineer
DR	Design Reliability
DRD	Data Requirements Description
DRL	Data Requirements List
DWR	Deviation Waiver Request
EEE	Electrical, Electronic, and Electromechanical
ELV	Expendable Launch Vehicle
EPROM	Erasable Programmable Read Only Memory
EPRS	Electronic Purchase Request System
ESD	Electrostatic Discharge
ESDS	ESD Sensitive
EWR	Eastern Western Range
FAR	Federal Acquisition Regulation
FIOS	Fabrication and Inspection Operations Sheet
FMEA	Failure Modes and Effects Analysis
FRR	Flight Readiness Review
FSA	Flight Safety Analysis
FSDP	Flight Safety Data Package
FTA	Fault Tree Analysis

FTR	Final Test Report
FWR	Fabrication Work Request
GB	Guidebook
GIDEP	Government-Industry Data Exchange Program
GSA	Ground Safety Analysis
GSDP	Ground Safety Data Package
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
ID	Identification
IDP	Integrated Data Package
IEEE	Institute of Electrical and Electronic Engineers
ISO	International Organization of Standardization
ITP	Integrated Test Plan
JSC	Johnson Space Center
KSC	Kennedy Space Center
LaRC	Langley Research Center
LHB	Langley Handbook
LAPD	Langley Policy and Directives
LPR	Langley Procedural Requirements
LMS	Langley Management System
LLIS	Lessons Learned Information System
LoD	Letter of Delegation
LRU	Line Replaceable Unit
LSMOB	Launch Services and Mission Orientation Briefing
MASR	Mission Approval Safety Review
MIL-HDBK	Military Handbook
MIL-STD	Military Standard
MRB	Material Review Board
MSC	Mission Success Criteria
MSFC	Marshall Space Flight Center
NARS	NASA Alert Reporting System
NASA	National Aeronautics and Space Administration
NDE	Nondestructive Evaluation
NFR	Nonconformance-Failure Report
NHB	NASA Handbook
NPR	Numerical Periodic Rating
NSTS	National Space Transportation System
OMA	Office of Mission Assurance

OP	Office of Procurement
OSMA	Office of Safety, and Mission Assurance
SFAO	Safety and Facility Assurance Office
OSPS	Security and Public Safety Office
PA	Product Assurance
P&M	Parts and Materials
PAP	Product Assurance Plan
PAM	Product Assurance Manager
PARs	Product Assurance Requirements
PCB	Projects Controls Branch
PDR	Preliminary Design Review
PIR	Parts Inventory Report
PR	Purchase Request
PROM	Programmable Read Only Memory
PR	Purchase Request
QA	Quality Assurance
QAR	Quality Assurance Representative
QAS	Quality Assurance Specialist
QATB	Quality Applications Technology Branch
QLTR	Quick-Look Test Report
QSS	Quality Status Stamps
RFP	Request for Proposals
RG	Reliability Goal
RIQAL	Receipt Inspection Quality Assurance Laboratory
ROM	Read Only Memory
SAR	Systems Acceptance Review
SCDP	Safety Compliance Data Package
SOW	Statement of Work
SPEC	Specification
SPO	Space Projects Office
SQAP	Software Quality Assurance Plan
SRR	Systems Requirements Review
SSP	System Safety Plan
STD	Standard

APPENDIX B

APPLICABLE DOCUMENTS

A1: Program and Project Management Documents

- LAPD 5300.1, “Program Assurance.”
- Langley Management System (LMS) Policy Manual
- NASA Procedural Requirements (NPR) 7120.5, “NASA Program and Project Management Processes and Requirements.”
- NASA Policy Directive (NPD) 8730.3, "NASA Quality Management System Policy (ISO 9000).”
- NPD 7120.4, "Program/Project Management."

A2: Product Assurance Plans

A3: Acquisition Quality Assurance

- NASA FAR Supplement (Paragraph 18-42.202-70).
- LMS-CP-4759, “Receipt, Handling, Storage, Marking, Preservation and Delivery of Hazardous Materials.”

A4: Configuration Management

- American National Standards Institute/institute of Electrical and Electronic Engineers (ANSWEEE) Standard 1042-1987, "IEEE Guide to Software Configuration Management."
- LPR 7320.1, "Engineering Drawing System."
- Military Standard (MIL-STD) -100, "Engineering Drawing Practices."
- MIL-STD-973, "Configuration Management."
- NASA-Guidebook (GB)-9503, "Software Configuration Management Guidebook."
- NPR 7120.5, "Program and Project Management Processes and Requirements."

A5: Design Assurance

- Military Handbook (MIL-HDBK) - 217, "Reliability Prediction of Electronic Equipment."
- MIL-STD - 756, "Reliability Modeling and Prediction."
- MIL-STD-1629, "Procedures for Performing a Failure Mode, Effects and Criticality Analysis."
- NASA-Standard(STD)-5001, "Structural Design and Test Factors of Safety for Spaceflight Hardware."
- NASA-STD-5002, "Load Analyses of Spacecraft and Payloads."
- NASA-STD-7001, "Payload Vibroacoustic Test Criteria."
- NASA-STD-7002, "Payload Test Requirements."
- NPD 8710.3, “NASA Policy for Limiting Debris Generation.”
- NPD 8730.3, "NASA Quality Management System Policy (ISO 9000)."
- NASA Space Transportation System (NSTS) 22206, "Instructions for Preparation of Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL)."
- NSS 1740.14, “Guidelines and Assessment Procedure for Limiting Orbital Debris.”
- "Nonelectronic Parts Reliability Data (NPRD) 1995."

A6: Parts and Materials

- Johnson Space Center (JSC) 09604F/MSFC-HDBK-527, "Materials Selection List for Space Hardware Systems."
- LAPD 5330.3, "Langley Research Center (LaRC) Standards for the Acquisition or Use of Threaded Fasteners."
- MIL-STD-975, "NASA Standard Electrical, Electronic, and Electromechanical (EEE) Parts List."
- Marshall Space Flight Center (MSFC)-Specification (SPEC)-522, "Design Criteria for Controlling Stress Corrosion Cracking."
- NPD 8730.2, "NASA Parts Policy."

- Preferred Parts List (PPL) -18, "Goddard Space Flight Center (GSFC) Preferred Parts List."

A7: Quality Assurance

- Federal-Standard-209, "Clean Room and Work Station Requirements, Controlled Environment."

- GEVG-LaRC/SED, "General Environmental Verification Guidelines for STS and ELV Payloads, Subsystems and Components."

- Kennedy Handbook (KHB) 1700.7, "Space Transportation System Payload Ground Safety Handbook."

- LPR 1740.2, "Facility Safety Requirements."

- SN-C-005, "Specification, Contamination Control Requirements for the Space Shuttle Program."

- SN-D-0007A, "NSTS Acceptance Data Package Requirements."

- LMS-CP-4750, “Develop Product Assurance Plans”

- LMS-CP-4751, “Response to Requests for Mission Assurance Support in Proposal or Contract Development”

- LMS-CP-4754, “Quality Assurance (QA) for Software Development and Acquisition”

- LMS-CP-4703, “Review of Purchase Requests by the Office of Safety and Mission Assurance (OSMA)”

- LMS-CP-4706, “Monitoring and Reporting of Receipt Inspection and Quality Assurance Testing Results Performed by the Receipt Inspection Quality Assurance Lab”

- LMS-OP-5515, “Electrical, Electronic, Electromechanical (EEE) Parts Assurance”

- LMS-CP-5528, “Software Planning, Development, Acquisition, Maintenance and Operation”

- LMS-CP-0506, “Selection, Use and Control of Inspection, Measuring, and Test Equipment”

- LMS-CP-0510, “Procurement of Inspection, Measuring and Test Equipment (IM&TE)”

- LMS-CP-4758, “Receipt Inspection of Safety-Critical Products”
- LMS-CP-5640,“Fabrication”
- LMS-CP-5643, “Fabrication Inspection Operations Sheet (FIOS) Administration Following Revisions, Operation Changes and Identification of Nonconformances”
- LMS-CP-4892, “Bonded Storage”
- LMS-CP-4756, “Handling, Preservation, Storage, and Shipping of Space Flight Hardware”
- NASA STD 8739.7 “Electrostatic Discharge Control”

A8: System Safety

- Eastern Western Range (EWR)127-1, "Eastern and Western Range Safety Requirements."
- JSC 11123, "Space Transportation System Payload Safety Guidelines Handbook."
- JSC 26943, "Guidelines for the Preparation of Payload Flight Safety Data Packages and Hazard Reports for Payloads Using the Space Shuttle."
- KHB 1700.7, "Space Shuttle Payload Ground Safety Handbook."
- NASA-STD-5003, "Fracture Control Requirements for Payloads Using the Space Shuttle."
- NASA-STD-5005, "Ground Support Equipment."
- NSTS 1700.7, "Safety Policy and Requirements for Payloads Using the Space Transportation System."
- NSTS 13830, "Implementation Procedure for NSTS Payloads System Safety Requirements."

APPENDIX C

Product Assurance Plan (PAP) Outline

1.0 GENERAL

1.1 Applicability
1.2 Project Related Documents
1.3 Project Description
1.4 Project Organization
1.5 Mission Success Criteria
1.6 Product Assurance Content and Deliverables
1.7 Product Assurance Plan Approval and Changes
1.8 Assessment

2.0 ACQUISITION QUALITY ASSURANCE

2.1 Acquisitions
2.2 Delegation of Quality Functions
2.3 Contract Deviations and Waivers

3.0 CONFIGURATION MANAGEMENT

3.1 Implementation
3.2 Configuration Items
3.3 Configuration Identification
3.4 Baseline Management
3.5 Change Control
3.6 Accounting
3.7 Verification

4.0 DESIGN ASSURANCE

4.1 Design Reviews
4.2 Design Reliability
4.3 Parts and Material Alerts
4.4 Orbital Debris Analysis

5.0 PARTS AND MATERIAL SELECTION

5.1 Mechanical Parts
5.2 EEE Parts
5.3 Materials Selection

6.0 QUALITY ASSURANCE

6.1 Institutional Safety Interface
6.2 Software
6.3 Metrology
6.4 Receiving and Inspection
6.5 Fabrication Planning
6.6 Hardware Identification
6.7 Nonconformance and Failure Reporting
6.8 Quality Stamps
6.9 Bonded Stores
6.10 Log Books
6.11 Assembly and Integration
6.12 Testing
6.13 Electrostatic Discharge Control
6.14 Contamination Control
6.15 Integrated Data Package
6.16 Handling, Preservation, and Shipping

7.0 SYSTEM SAFETY

7.1 System Safety Plan
7.2 Safety Data Package
7.3 Flight Safety Analysis
7.4 Ground Safety Analysis
7.5 NSTS Payload Review and Approval Process
7.6 ELV Payload Review and Approval Process